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Advance Review on Potential Characteristic Features of Some Bio-Fertilizers & Their Future Prospect in Agriculture Sector

Agriculture

KEYWORDS : Biofertilizer, Agriculture, soil fertility

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ABSTRACT

Soil infertility is important factor for decreased crop yield for a nations. The use of chemical fertilizers destroy the quality of soil in long run and also responsible for water, air, soil pollution and can cause cancer through food chain. Bio-fertilizers are emerging one of the best tool in agriculture sectorand applied in the agricultural field as a replacement to chemical fertilizers. Bio-fertilizer contain living microorganisms which promote the adequate supply of nutrients to the soil as well as promote plant growth. Microrganisms commonly used as biofertilizers are nitrogen fixers, K-solubilizer and phosphorus, or the combination of molds or fungi. Bio-fertilizers plays a vital role in agriculture sector by increasing crop production without affecting soil quality.

INTRODUCTION

Agriculture is one of the important sector for the economic growth of India. Out of 329 million hectare geographical area about 114 million hectares are under cultivation (Raghuwanshi 2012). Farmers inoculate soil with fertilizer for better harvest. Fertilizers act as catalysts and provide nutrients to plants for better growth and yield. Fertilizers can be categorized into three types: chemical, organic and biofertilizer. Biofertilizer is an organic product containing a specific microorganism in concentrated form, which is derived either from the plant roots or from plant root zone. It support to improve plant growth and yield (Gupta and Sen, 2013). These bioinoculants contain living microorganisms, colonize in the rhizosphere, or the interior of the plant. They promote growth when applied to seed, plant surfaces, or soil (Raghuwanshi, 2012). The production of biofertilizers in the country is 10,000 mt / annum and the production capacity is 18,000 mt / annum. Average annual consumption of biofertilizers in the country is around 64g/ha. Biofertilizers add nutrients (through fixation &solubilisation), stimulating plant growth and protect from pests and diseases (Rokhzadi *et al*., 2008). The biofertilizer are also called 'microbial inoculants', commonly used organisms are nitrogen fixers, potassium & phosphorus solubilizer, with combination of molds or fungi (Wani *et al* 1995). There are 17 essential elements required for proper plant growth. The deficiency of any of these nutrients, result in severe damage to crop health and yield. Out of these elements, nitrogen, phosphorous, and potassium are needed in great quantiy, Silicon (Si) and sodium (Na) are considered essential nutrients, present abundantly. (Parikh and James, 2012).

Nitrogen

Nitrogen is essential nutrients for crops. Biological nitrogen fixation is one way of converting elemental nitrogen to available form (Gothwal *et al*., 2007). Atmospheric nitrogen is converted to nitrate by few microorganisms in soil. Nitrogen-fixing bacteria (NFB) transform atmospheric N2 to organic compounds (Bakulin *et al*., 2007). Nitrogen fixation can provide 300-400 kg N/ha/ yr (Adam, 2002). The quality of soil and higher crop yield can be achieved by applying biofertilizers. (Kannaiyan, 2002). Biofertilizers can add 20-200kg N /ha by fixation and increase crop yield by 10-50%. In plants up to 25% of total nitrogen came from fixation. Roots of plants release substances into soil, which support colonization and nitrogen fixing by bacteria in rhizosphere of plants (Nghia and Gyurjan, 1987). The bio-fertilizers enhance the growth of root system to increase the water and nutrient absorption abilities. Biofertilizer extend the life of root, neutralize and degrade harmful materials present in soil, promote survival efficiency of seedling after transplanting and get shorter time for flowering. **(**Youssef and Eissa, 2014).

Azobacter can fix atmospheric nitrogen in cereal crops without any symbiosis (Gupta, 2004). Co-inoculation (*Pseudomonas* and *Bacillus)* strains along with *Rhizobium* sp. stimulate chickpea growth, nodulation and nitrogen by fixation. Mohammadi *et al*. (2010) reported that the highest sugar, protein, starch contents, nodule weight and seed nitrogen, potassium, phosphorus of chickpea were obtained from combined application of phosphate solubilizing bacteria, *Rhizobium* and *Trichoderma* fungus. Shanmugam and Veeraputhran (2000) stated that application of green manure and biofertilizer stimulated the growth of plants with more number of tillers and increased leaf area in rice. Jeeva (1987) reported that the production of the IAA, gibberellins and cytokinins like substances are produced by the bacterium.

Rhizobium: belongs to family *Rhizobiaceae,* symbiotic in nature and fixes 50-100 kg N/ha, with legumes only. *Rhizobium* has the ability to fix nitrogen in symbiotic association with legumes and non-legumes(*Parasponia).*

Azotobacter: belongs to family Azotobacteriaceae; it is aerobic, free living, heterotrophic and sacharophillic bacteria, associate with sugarcane, sweet potato and sweet sorghum plants and fixes 30 kgs/ N/ ha year. Mainly this bacterium is commercialized for sugarcane crop. It is known to increase yield by 10-20 t/ acre and sugar content about 10-15%. *Azotobacters* are present in neutral or alkaline soils. *A. vinelandii, A. beijerinckii, A. insignis* and *A.macrocytogenes* are also common species. *Azotobacter* produces anti-fungal antibiotics that inhibit the growth of several pathogenic fungi in the root zone and help prevent seedling mortality. The occurrence of this organism has been reported in the rhizosphere of a number of crop plants such as rice, maize, sugarcane, bajra, vegetables and plantation crops.

Azospirillum- It fixes about 20-40 kg N/ha and also produce growth-regulating substances.*Azospirillum* form associative symbiosis with many plants particularly with C4 plants mainly maize, sugarcane, Oilseeds, cotton, sorghum, pearl millet etc . El-Komy (2005) demonstrated the beneficial influence of co-inoculation of *Azospirillum lipoferum* and *Bacillus megaterium* for providing balanced nitrogen and phosphorus nutrition of wheat

plants. The inoculation with bacterial addition provide a more balanced nutrition for the plants and the improvement in root uptake of nitrogen and phosphorus.

Blue Green Algae (Cyanobacteria): These are phototrophic and produce auxin, indole acetic acid and gibberllic acid. They fix 20-30 kg N/ha in rice fields. N is the key input required in large quantities for low land rice production. 50-60% N requirement is met through the combination of organic N and BNF (by free living and associated bacteria).

Azolla is a free-floating water fern, floats in water. It contains 4-5% N (on dry basis) and 0.2-0.4% (on wet basis) and can be the potential source of organic manure and nitrogen in rice production. The important factor in using Azolla as biofertilizer for rice crop is its quick decomposition in the soil and efficient availability of nitrogen to rice. The most common species occurring in India is *A. pinnata* and commercially produced by vegetative means. In India, large production of biomass of Azolla species as green manure are *A.caroliniana, A. microphylla, A. filiculoides and A. mexicana.* (Mian and Kashem 1995). *Azolla as* biofertilizer is used for rice cultivation in different countries such as Vietnam, China, Thailand and Philippines. The rice yields can increased by 0.5-2 t/ha due to *Azolla* application (Gupta, 2004).

Phosphorus

The plants cannot take phosphorus directly from soil, several bacteria and a few fungal sp secret acids which convert insoluble phosphate to soluble forms(Gupta, 2004). These acids lower the soil pH and dissolute bound forms of phosphate. Bacteria are more effective in phosphate solubilization than fungi (Alam *et al.*, 2002). Phosphate solubilization takes place through various microbial processes including acid production and proton extrusion (Sagoe *et al.*, 1998). The Phosphate solubilization potential of bacteria and fungi are different. (Chen *et al.*, 2006). Microorganisms involved in phosphorus solubalization include mycorrhizal fungi and PSMs (Fankem *et al.,* 2006). Highest number of PSM are present in the rhizosphere, and they are metabolically more active than other sources (Vazquez *et al.*, 2000). The PSB are ubiquitous vary in different soil (Kim *et al.*, 1998). Some bacterial species have mineralization and solubilization potential for organic and inorganic phosphorus, respectively (Khiari and Parent, 2005). Inorganic P is solubilized by acids secreted by PSB in which hydroxyl and carboxyl groups of acids(gluconic and ketogluconic) chelate cations (Al, Fe, Ca) and decrease the pH in basic soils (Ponmurugan and Gopi, 2006). Release of root exudates such as organic ligands can also alter the concentration of P in soil (Hinsinger, 2001). The PSB solubilize the fixed soil P and resulting in higher crop yields (Gull *et al.*, 2004).

Mycorrhiza : It is a symbiotic association between host plants and certain group of fungi. In this association the host obtain essential nutrients especially phosphorus with fine absorbing hyphae of the fungus. These fungi are associated with majority of agricultural crops, except with those belongs to families of *Chenopodiaceae, Amaranthaceae, Caryophyllaceae, Polygonaceae, Brassicaceae, Commelinaceae, Juncaceae and Cyperaceae.* VAM is fungi that are associated with of agriculture crops and enhance accumulation of nutrients. It also stimulate plant growth or reduce the severity of diseases (Gupta, 2004).

PLANT GROWTH PROMOTING RHIZOBACTERIA(PGPR)

A group of rhizosphere bacteria that exerts a beneficial effect on plant growth is referred to as Plant Growth Promoting Rhizobacteria. (Schroth and Hacock, 1981). PGPR belong to several genera, e.g. *Agrobacterium, Alcaligenes, Arthrobacter, Actinoplanes, Azotobacter, Bacillus*, *Pseudomonas* sp., *Rhizobium*, *Bradyrhizobium*, *Erwinia*, *Enterobacter*, *Amorpho sporangium*, *Cellulomonas*, *Flavobacterium*, *Streptomyces* and *Xanthomonas* (Weller, 1988). Single bacterial cells can attach to surfaces of the plant and form dense macro colonies by cell division and proliferation. The colonization and growth of PGPR establish interactions with plants (Nihorimbere *et al.*, 2011). Plant roots initiate producing signals that are recognized by the soil microbe, which in initiate colonization (Berg, 2009). PGPR reach root surfaces by active motility facilitated by flagella and by chemotactic responses. The PGPR highly depends on their abilities to adapt to changing conditions or plant species (Nihorimbere *et al.*,2011).

Zinc: Mycorrhiza can be used as bio-fertilizer as supply micronutrients (like zinc, iron, copper) to plants. (Raj 2007).The microorganisms like *B. subtilis, Thiobacillus thioxidans and Saccharomyces sp.* can also solubilized Zn.

Silicate - Microorganisms are capable of degrading silicates and aluminum silicates.The microbial metabolism, play role in silicate weathering.

ROLE OF BIO-FERTILIZERS IN AGRICULTURE SECTOR

The biofertilizers play an important role in improving soil fertility (Kachroo and Razdan 2006) Biofertilizers increase grain yield and harvest. Their application in soil, improves soil microbiology as compare to chemical fertilizers. In the modern approach of disease management, biofertilizers play a significant role in agriculture (Li Bin *et al* 2005., Hossain *et al.,* 2009). Growth, yield and quality parameters of certain plant significantly increases by biofertilizers. (Youssef and Eissa, 2014). In India most of the soils are acidic and alkaline/saline. Therefore, inoculants with PSB and other useful microorganism, restore and maintain microbial populations for phosphorus solubilisation and availability of macro and micronutrients for good yield of various crops.

CONCLUSIONS

To achieve sustainability in agriculture sector, biofertilizers are essential, as the economic growth of India depends on agriculture. Sustainable agriculture is defined as environment friendly methods that allow the production of crops and livestock without damaging natural resource. Soil fertility is diminishing gradually due to soil erosions, loss of nutrition, accumulations of toxic element etc. Organic manure or biofertilizer are the alternate sources to meet the nutrient requirement of the crops and play vital role in maintaining soil fertility by fixing nitrogen, mobilizing fixed macro and micro nutrients by converting insoluble P to available P to plants. Bio-fertilizers would be the viable option for farmers to increase productivity per unit area. Furthermore, biofertilizer can be used as substitute of chemical fertilizers as it reduces amount and cost of chemical fertilizers and prevents the environment pollution. The proper application and use of biofertilizers will not have an impact on sustainable agriculture or economic development but will contribute to a sustainable ecosystem.

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